

RoboJackets



The Arthur M. Blank Family Foundation

2007 Adv TE Sessions – Computer Vision

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www.robojackets.org







Why use vision?



- Tremendous amount of information
 - Spatial
 - Temporal
 - Radiometric
- Cost
- Passive
- Size
- Our "primary" sensor

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Image Representation





Matrix representation of image data
Data "cube"
Origin at upper left





Filtering





ConvolutionThresholding





Convolution







Other Masks... **Gaussian Blur**





- More weight given to center pixel
 Approximates image resizing, real world blur.
- Resistant to outliers
- Enemy of noise

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Other Masks... Robert's Edge Detector







Thresholding





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if (pixel > threshold) white else black

Useful for

- Color recognition
 Crude image compression



Feature Detecting





- Active area of research
- Harris Corner Detector
- SIFT Feature Detector
- By hand...

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Feature Matching





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- Active area of research
- Particle FilteringRANSAC

- Bundle Adjustment
 Expectation Maximization



Video Google







Retrieved key-frames from three different shots

















Wide Baseline Stereo





Video: PhotoSynth Video: 4D Cities





SLAM Self Localization and Mapping



Uses features and stereo equations to compute its location and map it's environment

Equations solved, features still need work.

Without other sensors, no sense of scale.

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Bullet Time!





Video: The Matrix - Bullet Time •Stereo •View Morphing





Projections





Catadioptric Camera (latin for mirror + lens)

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The World in an Eye







(a) Eye image (cropped)



(b) Spherical Panorama (cropped)



(c) Foveated retinal image (45° FOV)(I) Interacting with a Computer

Nayar '04



Clustering



Clusters on color

Image

Clusters on intensity

K-means clustering on intensity and color





K-Means Clustering





- AlgorithmFix cluster centers and allocate points to closest center.Find centroid of clusters and
- recompute.Stop when no points change alliegences.

2006 Warner Independent Pictures



Roboleckers

Rotoscoping **A Scanner Darkly**





Done semiautomaticlly in the movie, techniques exist to do it automatically.

Techniques Used Linear Filtering Clustering Edge Detection

2006 Warner Independent Pictures



Expectation Maximization



- Objective:
 - Robust fit of a model to data S
- Algorithm
 - Randomly select s data points
 - Make a model with those points
 - Get consensus set S
 - If |S|>T, terminate and return model
 - Repeat for N trials, return model with max |S|
 - Optional: refine returned model





Mosaicking





Techniques Used Feature Detection and Matching Model Fitting Expectation Maximization Graph Cuts (optional)

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Images Courtesy Frank Dellaert



Driving





- Competitions DARPA Grand Challenge DARPA Urban Challenge IGVC
- LAGR



- ApplictionsStructured and unstructured road followingLane detection
- Pedestrian detection / avoidance
- Signal detectionCruise control

- Merge assistanceDriver impairment detection









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